What is claimed is:

1. A return loss channel detector apparatus comprising:

a directional coupler having an RF output for coupling to the RF input of an analog television or analog video tape recorder (hereafter TVR) and having a transmit input for receiving probe signals and a transmit output at which appears probe signals reflected from said TVR;

a multiplexer having an output coupled to said transmit input and having a first input for receiving a radio frequency carrier having a video signal modulated thereon and having a second input for receiving probe signals;

a transmitter for generating probe signals; and

a receiver for receiving reflected probe signals and calculating a return loss ratio therefrom.

2. The apparatus of claim 1 wherein said transmitter includes means for generating probe signals that have frequencies spread out through a band of frequencies in which TV channels are transmitted.

3. The apparatus of claim 2 wherein said receiver includes means for calculating return loss ratios for all probe signals generated by said transmitter and storing the results as the signature for a TV channel to which said TVR is tuned.

4. The apparatus of claim 3 wherein said transmitter further comprises means for calculating a calibration coefficient for each probe signal, and wherein said means for calculating return loss ratios for said probe signal includes means for using the calibration coefficient for each probe signal in making the return loss ratio calculation for said probe signal.

5. The apparatus of claim 1 wherein said transmitter includes a probe signal generator comprising:

a first clock for generating a first sample frequency and having a clock signal output;

a second clock for generating a second sample frequency which is different than said first sample frequency and having a clock signal output;

a multiplexer having first and second inputs coupled to said outputs of said first and second clocks, respectively, and having an output;

a digital to analog converter (D/A) having a sampling clock signal input coupled to said output of said multiplexer and having a digital signal input and having an output for coupling to said transmit input of said directional coupler, said D/A using a zero order hold process to construct an analog signal from a digital signal representation received at said digital signal input,

a direct digital synthesizer having a digital signal output coupled to said digital signal input of said D/A and having a control word input for receiving a control word which controls the frequency of the signal represented digitally by data output on said digital signal output.

6. The apparatus of claim 1 wherein said transmitter includes a probe signal generator comprising:

a variable frequency clock having a frequency control input and having an output at which a sampling clock signal having a frequency established by a signal received at said frequency control input;

a digital to analog converter (D/A) having a sampling clock signal input coupled to said output of said variable frequency clock, and having a digital signal input and having an output for coupling to said transmit input of said directional coupler, said D/A using a zero order hold process to construct an analog signal from a digital signal representation received at said digital signal input,

a direct digital synthesizer having a digital signal output coupled to said digital signal input of said D/A and having a control word input for receiving a control word which controls the frequency of the signal represented digitally by data output on said digital signal output.

7. The apparatus of claim 5 wherein said receiver is comprised of:

an analog to digital converter (A/D) operating on a different sample clock frequency than said D/A, and having an digital signal output;

a plurality of digital signal bandpass filters having filter coefficient inputs;

a control circuit coupled to said bandpass filters to establish filter coefficients for each one which establishes for each bandpass filter a passband which encompasses a reflected probe signal's bandwidth appearing in the digital representation of a reflected signal at said digital signal output of said A/D, each said bandpass filter having an output;

first means coupled to each said output of said bandpass filters for calculating and outputting at a separate output for each bandpass filter the term $\mathrm{abs}(X_{out}(j\omega_k))^2$ where X_{out} is the aliased frequency of a probe signal having a frequency X_{in} which the passband of said bandpass filter encompasses;

second means having a separate input coupled to each said separate output of said first means for calculating and outputting a return loss ratio for each probe signal selected by each said bandpass filter using the equation $RL_c(j\omega_k) = 10\log_{10}(C(k) * \mathrm{abs}(X_{out}(j\omega_k))^2)$.

8. The apparatus of claim 7 wherein said receiver further comprises means for storing signatures for each channel and for using said signatures and return loss ratio measurement to determine a TV channel to which said TVR is tuned and outputting requested channel data indicating the TV channel to which said user has tuned said TVR, and for tracking which TV channel to said TVR is tuned over time and altering said requested channel data when the TV channel to which said TVR is tuned has been changed, and further comprising a set top box means coupled to said return loss channel detector apparatus for using said requested channel data output by said return loss channel detector apparatus indicating a desired channel number to be viewed and tuning to a radio frequency carrier modulated with data that encodes a television signal being transmitted on said desired TV channel to which said TVR has been tuned, and for recovering said data and converting said data to a television signal.

9. The apparatus of claim 8 further comprising means in said set top box means for modulating said television signal onto a radio frequency carrier signal at the frequency of said desired channel number and supplying said carrier to an RF output adapted for coupling to an RF input of a TV or VCR.

10. The apparatus of claim 8 wherein said set top box means includes means to use said requested channel data to determine if a conditional access key is needed for said selected channel, and, if so, send an upstream DOCSIS message requesting the necessary session key, and for receiving a downstream message containing the requested session key, and for decrypting said session key using a secret user key, and using said decrypted session key to decrypt a working key transmitted with the data of the requested channel and using said decrypted working key to decrypt data of said requested channel.

11. The apparatus of claim 10 further comprising an infrared transceiver and setup means for using said infrared transceiver to complete a setup process to use said return loss channel detector to learn said signature of every TV channel to which a tuner in said TVR coupled to said return loss channel detector apparatus is tuned.

12. The apparatus of claim 11 wherein said set top box means includes a radio frequency receiver coupled to a control processor and wherein said setup means functions to use said radio frequency receiver and processor to receive a radio frequency command indicating the channel to which a TVR tuner has been tuned during said setup process, said radio frequency command sent from a remote control used during said setup process to change channels to which a tuner of a TVR is tuned.

13. A process for determining if an analog TV or VCR (hereafter TVR) is tuned to a particular TV channel, comprising the steps:

(1) generating one or more probe signals having frequencies within the passband or some of which are within and some of which are without the passband of a tunable bandpass filter within a tuner of a TVR when said TVR is tuned to a particular TV channel;

(2) transmitting said probe signals to an RF tuner input of said TVR and coupling reflected power back to an input of a receiver;

(3) in said receiver calculating a return loss ratio and determining therefrom whether said TVR is tuned to said particular TV channel.

14. The process of claim 13 wherein step 1 comprises generating a plurality of probe signals having frequencies that are spread throughout the entire TV channel band, and

wherein step 2 comprises transmitting a plurality of probe siganals to said TVR simultaneously, and wherein step 3 comprises setting the filter coefficients each of a purality of bandpass filters in said receiver such that said bandpass filter has a passband which encompasses the frequency at which a different one of said probe signals appears at the input to said bandpass filter, and calculating a return loss ratio on the output signal from each said bandpass filter.

15. The process of claim 14 further comprising the step of calculating a calibration coefficient for each probe signal frequency and using said calibration coefficient for each probe signal frequency in a calculation of a return loss ratio for said probe signal to compensate for frequency dependent variations that affect the probe signals.

16. The process of claim 15 wherein step 1 comprises the steps of:

calculating the frequency of a basic replica frequency which will yield a plurality of replica images at higher frequencies when a digital representation of said basic replica frequency is converted to an analog signal by a digital to analog converter (D/A) operating using a zero order hold method to construct an analog signal from discrete samples;

generating a digital representation of said basic replica frequency and applying same to the digital input of a D/A operating using a zero order hold method so as to generate a plurality of analog probe signals at an output of said D/A.

17. The process of claim 15 wherein step 1 comprises the steps of:

calculating the frequency of a basic replica frequency which will yield a plurality of replica images at higher frequencies when a digital representation of said basic replica frequency is converted to an analog signal by a digital to analog converter (D/A) operating using a zero order hold method to construct an analog signal from discrete samples;

calculating a Sinc function power mask for the sampling frequency of said D/A ;

determining if one or more desired probe signals to be generated as replica images of said basic replica frequency have frequencies in nulls or high attenuation regions of said power mask;

if one or more desired probe signals to be generated as replica images of said basid replica frequency have frequencies in a null or high attenuation region of said power mask, changing the sampling frequency of said D/A such that the Sinc function power mask of the new sampling frequency does not have a null or high attenuation region at the frequency of any desired probe signal;

generating a digital representation of said basic replica frequency and applying same to the digital input of a D/A operating using a zero order hold method so as to generate a plurality of analog probe signals at an output of said D/A.

18. A process for using return loss to verify a TV channel to which a TVR is tuned, comprising the steps:

1) detecting a local oscillator leakage signal and counting the frequency thereof and using said frequency to lookup a TV channel to which a TVR is tuned which would cause said local oscillator to have said frequency;

2) generating and transmitting into an RF input of said TVR a plurality of probe signals having frequencies spread through a band of frequencies in which TV channels are transmitted;

3) determining the transmitted power of each probe signal;

4) measuring the reflected power of each probe signal;

5) calculating the return loss ratio for each probe signal;

6) determining the probe signal with the maximum return loss;

7) determine the TV channel whose frequency has the best match with the probe signal which suffered the highest return loss;

8) determining if the TV channel determined in step 7 is the same as the TV channel determined in step 1;

9) if step 8 determines the TV channels are different, use the TV channel determined in step 7 and generate suitable control signals for use by a set top decoder to tune to a downstream channel carrying the TV channel determined in step 7 and recover the data thereof and convert said data to a television signal and modulate an RF carrier having the frequency of the TV channel determined in step 7 with said television signal;

10) if step 8 determines the TV channels are the same, use the TV channel determined in steps 7 and 1 and generate suitable control signals for use by a set top

decoder to tune to a downstream channel carrying the TV channel determined in step 7 and recover the data thereof and convert said data to a television signal and modulate an RF carrier having the frequency of the TV channel determined in step 7 with said television signal.

19. A process for using return loss to determine a TV channel to which a TVR is is tuned, comprising the steps:

1) performing a setup process to learn the signature of each TV channel comprised of the return loss ratios of a plurality of probe signals which have frequencies spread throughout the TV channel band, and storing the signature for each TV channel;

2) determing the TV channel to which a TVR is currently tuned by performing the following steps:

3) generating a plurality of probe signals having frequencies which are spread through the band of frequencies in which TV channels are transmitted and transmitting said probe signals into the RF input of a tuner of a TVR;

4) calculating the return loss ratio on each probe signal;

5) comparing the collection of return loss ratios and comparing the collection of return loss ratios to the signature stored in memory for each TV channel and determining the TV channel have the least difference between its signature and said collection of return loss ratios calculated in step 4;

generating suitable control signals to control a set top decoder to tune to a downstream channel carrying the TV channel determined in step 5 and recover the data thereof and convert said data to a television signal and modulate an RF carrier having the frequency of the TV channel determined in step 5 with said television signal.

20. A setup process for learning the return loss ratio signature of each TV channel comprising steps for:

1) establishing the proper infrared protocol for at least channel change commands to be emitted from an infrared transmitter;

2) entering a learning mode;

3) transmitting a channel change command from said infrared transmitter to cause a TVR connected to a set top decoder with a return loss ratio channel detection circuit therein to tune to a specific channel;

4) controlling said return loss ratio channel detection circuit to generate a plurality of probe signals and transmit them into the RF input of a tuner in said TVR;

5) measure the reflected amplitude of each said probe signal and calculate a return loss ratio therefor and store the collection of return loss ratios as a signature for the TV channel to which the TVR is currently tuned;

6) transmitting channel change command from said infrared transmitter to cause said TVR to change to a new channel;

7) repeating steps 4 and 5 for the new channel;

8) repeating steps 6 and 7 until a signature has been learned for every TV channel.

21. A setup process for learning the return loss ratio signature of each TV channel comprising steps for:

1) establishing the proper infrared protocol for at least channel change commands to be emitted from an infrared transmitter in an external remote control for a set top decoder (STB), said external remote control including an RF transmitter for communicating with an RF receiver in said STB, said STB including a return loss ratio channel detection circuit therein having an RF output for coupling to the RF input of a tuner of a TVR;

2) entering a learning mode;

3) transmitting a channel change command from said infrared transmitter in said external remote control to cause said TVR connected to said return loss ratio channel detection circuit to tune to a specific channel, and sending a radio frequency message to said STB telling said STB to which TV channel said TVR has just been tuned;

4) controlling said return loss ratio channel detection circuit to generate a plurality of probe signals and transmit them into said RF input of said tuner in said TVR;

5) measuring the reflected amplitude of each said probe signal and calculate a return loss ratio therefor and store the collection of return loss ratios as a signature for the TV channel to which the TVR is currently tuned;

6) transmitting channel change command from said infrared transmitter in said external remote control to cause said TVR to change to a new channel;

7) repeating steps 4 and 5 for the new channel;

8) repeating steps 6 and 7 until a signature has been learned for every TV channel.

22. A setup process for learning the return loss ratio signature of each TV channel comprising steps for:

1) transmitting a channel change command to a TVR using a remote control of said TVR so as to tune said TVR to a selected TV channel;

2) periodically or occasionally monitoring leakage from a local oscillator in a tuner of said TVR to determine the frequency at which said local oscillator is oscillating;

3) determining if the current frequency at which said local oscillator is oscillating has changed since the last time the frequency of said local oscillator was counted;

4) if the frequency of said local oscillator has not changed since the last time it was checked, return to step 2, but if the frequency of said local oscillator has changed since the last time it was checked, using the frequency of said local oscillator to determine the channel to which said TVR is tuned and then learn the return loss ratio signature of said TV channel to which said TVR is tuned and store said signature in memory;

5) determine if there is a match between the signature stored in step 4 and signatures previously stored;

6) if step 5 determines there is a match, generating and sending the appropriate commands to control a set top decoder to tune to a downstream channel carrying the TV channel determined in step 5 and recover the data thereof and convert said data to a television signal and modulate an RF carrier having the frequency of the TV channel determined in step 5 with said television signal,

7) determining if all signatures for all channels have been learned, and, if so, thereafter using said signatures in conjuction with return loss ratio measurements on a plurality of probe signals to determine the channel to which a TVR is tuned at any particular time, but if not all signatures have been learned, returning to step 2;

8) if step 5 determines that the signature learned in step 4 does not match any signature previously learned, labelling the signature data gathered in step 4 as the signature for the channel determined in step 4, and then returning to step 2.